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WATER RESOURCES STUDY AND PUBLIC HEALTH
ASPECTS OF THE BEAR RIVER PROJECT IDAHO AND
UTAH

Public Health Service
Denver, Colorado

December 1962

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**WATER RESOURCES STUDY AND
PUBLIC HEALTH ASPECTS
OF THE
BEAR RIVER PROJECT, IDAHO AND UTAH**

**Prepared at the Request of and in Cooperation
with the
Bureau of Reclamation, Region 4,
U. S. Department of Interior
Salt Lake City, Utah**

**U. S. Department of Health, Education, and Welfare
Public Health Service
Bureau of State Services
Division of Water Supply and Pollution Control
Region VIII
Denver, Colorado**

December 1962

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- B 38 Water resources study and public health aspects of Bear River project, Idaho and Utah (with bibliography). Denver, Colo., Dec. 1962 (Division of Water Supply and pollution Control.) (Prepared in cooperation with Reclamation Bureau, Region 4, Salt Lake City, Utah.) Environmental Protection Agency.

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PART I - STREAM QUALITY CONTROL NEEDS

I. INTRODUCTION

Authority

In accordance with the memorandum of understanding of September 28, 1956, between the Bureau of Reclamation, Region 4, Department of the Interior, and the U. S. Public Health Service, Department of Health, Education and Welfare, consideration has been given to the general public health aspects of the Bureau of Reclamation's proposed Bear River Project in Idaho and Utah. After a meeting of the two agencies at the Region 4 office of the Bureau of Reclamation on August 2, 1962, and in accordance with the subsequent letter of authorization of August 14, 1962, the study was expanded to cover the inclusion of storage for regulations of streamflow for the purpose of water quality control as set forth in Section 2b of the Federal Water Pollution Control Act (Public Law 660, 84th Congress as amended by Public Law 87-88, approved July 20, 1961).

Purpose and Scope

This report presents data and information relevant to the determination of water requirements to the year 2060, for the inclusion of storage for regulation of streamflow for the purpose of water quality control in the Lower Bear River Basin, Utah and Idaho. An estimate of the annual benefits which could be ascribed to storage allocated for this purpose is evolved from the projected economic developments and anticipated demands for water supply and stream quality control.

Acknowledgments

The cooperation and assistance of many persons and agencies are gratefully acknowledged by the Public Health Service. Special appreciation is expressed to the following:

City and Town officials in the Bear River Basin
Idaho Department of Health
Utah State Department of Health
University of Utah, Bureau of Economics and Business
Research
Bureau of Reclamation, Region 4 Office and the
Logan Development Office

II. SUMMARY AND CONCLUSIONS

Summary

1. The Bear River Project is a proposed Bureau of Reclamation development to provide supplemental water for presently irrigated land and full water supply for new lands in the Lower Bear River Basin -- Caribou, Franklin and Oneida counties, Idaho; Box Elder and Cache counties, Utah.
2. Irrigated agriculture is the principal industry in the project area. Dairying provides the largest source of farm income followed by sales of beef cattle and sheep. Trading centers are located at Malad, Soda Springs, Grace and Preston in Idaho; Brigham City, Logan, Smithfield and Tremonton in Utah.
3. There are 36 public water supply systems in the project area, 10 in Idaho and 26 in Utah. Of these, 8 utilize springs and wells, 2 utilize deep wells only, and 26 depend entirely upon springs to meet the domestic and industrial water supply demands. Treatment provided public water supplies in the area consists of chlorination only and this is practiced for 7 communities.
4. Under Section 8 of the Federal Water Pollution Control Act, Public Law 660, enforcement action to abate the pollution in the Bear River and its tributaries is under way.
5. Domestic wastes from 10 communities having a total P. E. of 35,000 and industrial wastes from 15 industries with a total P. E. of 930,000 are discharged to the Bear River and its tributaries. The sugar factories account for approximately 92 percent of the P. E. industrial waste discharge, however these factories generally operate only during the months of October and November.

Conclusions

1. The natural and agricultural resources in the project area constitute a potential for future industrial and municipal growth.
2. If economic development of the project area is to occur, surface water supplies must be developed to meet the anticipated water needs.

3. Technological advancement will lead to fuller utilization of the project area resources and undoubtedly will affect the water requirements in the basin.
4. The project area's population is expected to increase from 78,885 in 1960 to 99,200 by the year 1985; 126,500 by the year 2010; and 212,200 by the year 2060.
5. Benefits that would accrue through improved water quality due to savings of soap, detergents and general household cleansers from the reduction of hardness will average \$2,500 annually for Oneida Reservoir and \$11,200 annually for Cutler and Honeyville Reservoirs when discounted to present annual values.
6. No water quality control maintenance benefits can be attributed to the Bear River Project, as there is no apparent need for storage for regulation of streamflow for the purpose of water quality control at this time.

III. DESCRIPTION OF PROJECT

Location

The Bear River drainage basin covers the northeastern section of the Great Salt Lake Basin, including southeastern Idaho, northern Utah and southwestern Wyoming. The basin area of approximately 7100 square miles (2700 in Idaho, 2910 in Utah and 1490 in Wyoming) constitutes less than one-seventh of the area of the Great Basin, but within this area are concentrated more than two-thirds of the water resources and irrigated land of the Great Basin. The Bear River Project area is located in both the States of Idaho and Utah. Location of existing and proposed reservoirs, major project canals, and the Bear River Basin are shown on Figure 1.

Streamflow (1)

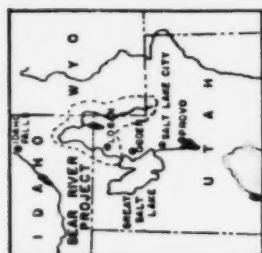
Natural flows of the Bear River and most of its tributaries vary widely at different times of the year and from year to year. Most of the streamflow originates in the mountainous areas where the snowfall and rainfall are comparatively heavy. Depending primarily upon the snowfall in December, January and February, the annual flows of the larger streams vary from 40 to 175 percent of the average. Approximately 60 percent of the annual streamflow occurs during April, May and June. Minimum flows on the main stem usually occur during July, August, September and October.

Table III-1 shows the period of record, maximum, minimum and average flows at selected gaging stations.

Water Quality

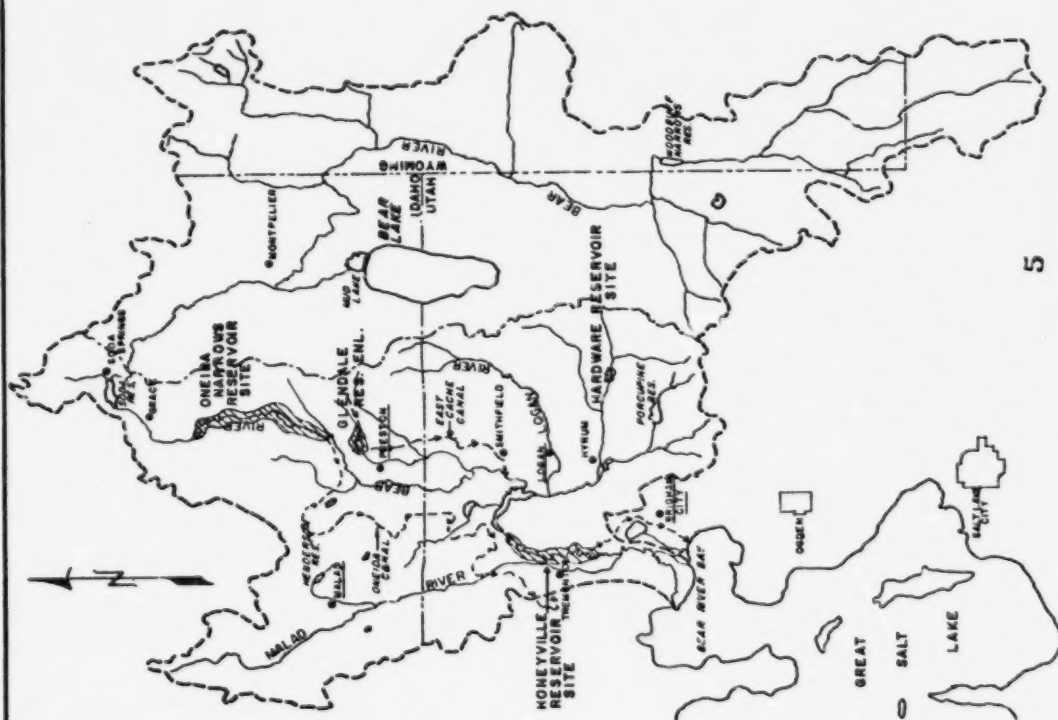
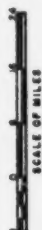
Waters available and utilized for domestic and industrial purposes in the project area are, in general, of good chemical quality. A cooperative study (2) of the water quality in the Lower Bear River, covering the period from July 1958 through September 1958, was concerned with the chemical and bacteriological quality of the Lower Bear River and its tributaries.

Table III-2 summarizes the bacteriological and chemical quality data of surface waters in the Lower Bear River Basin. On the basis of these data and the Public Health Service Drinking Water Standards, the surface waters in the study area were classified with respect to chemical and bacteriological quality, as a source of water supply for domestic purposes.



INDEX MAP

- LEGEND**
- EXISTING RES.
 - ▨ PROPOSED RES.
 - STATE BOUNDARY
 - - - PROJECT BOUNDARY
 - BASIN BOUNDARY



5

GENERAL MAP

BEAR RIVER PROJECT

DEPT. OF HEALTH, EDUCATION & WELFARE
PUBLIC HEALTH SERVICE
REGION VIII
DENVER, COLO.

FIGURE 1

TABLE III-1

Streamflow Data (U.S.G.S. Water-Supply Paper 1714, 1960)

Station	Period of Record	Flows		Average	
		Maximum (cfs)	Minimum (cfs)	(cfs)	(ac.-ft.year)
Bear River near Utah-Wyoming State Line <u>1/</u>	1942-60	2,800	16	185	133,900
Bear River near Woodruff Utah <u>2/</u>	1942-60	3,010	0	205	148,000
Bear River near Randolph, Utah <u>3/</u>	1943-60	2,660	4.8	188	136,100
Bear River at Border, Wyoming <u>4/</u>	1937-60	3,680	30	396	286,700
Bear River at Alexander, Idaho <u>5/</u>	1921-60	4,590	28	768	556,000
Bear River below power- plant at Oneida, Idaho <u>5/</u>	1911-60	4,740	15	792	573,400
Bear River near Preston, Idaho <u>5/</u>	1943-60	4,420	0.6	823	595,800
Cub River near Preston Idaho	1940-52) 1955-60)	715	11	84.8	61,390
Little Bear River near Paradise, Utah <u>6/</u>	1937-60	1,830	4	85.3	61,750
Little Bear River near Hyrum, Utah <u>7/</u>	1938-60	985	0.2	60.7	43,940
Logan River above State Dam near Logan, Utah <u>8/</u>	1913-60	2,000	6	105	76,020
Blacksmith Fork above diversions near Hyrum, Utah <u>9/</u>	1913-60	1,620	29	125	90,500
Bear River near Collinston, Utah <u>10/</u>	1889-1960	11,600	0	1,620	1,171,000
Malad River near Woodruff, Idaho <u>11/</u>	1939-60	650	3	61.7	44,670
Bear River near Corinne, Utah (discontinued) <u>10/</u>	1949-57	7,200	86	1,687	1,221,000

- 1/ Diversions above station for irrigation of about 2,800 acres
2/ Diversions above station for irrigation of about 45,000 acres
3/ Diversions above station for irrigation of about 96,000 acres
4/ Diversions above station for irrigation of about 124,000 acres
5/ Many diversions for irrigation above station. Flow regulated by Bear Lake and power plants above station
6/ Diversions above station for irrigation of about 2,800 acres
7/ Diversions above station for irrigation of about 10,400 acres.
8/ Diversions above station from river and springs for power, irrigation, and municipal water supply
9/ Small diversions above station for irrigation of about 200 acres
10/ Small diversions above station for irrigation of about 58,000 acres, flow affected by storage reservoirs, power developments, irrigation diversions, and irrigation return flows
11/ Diversions above station for irrigation of about 30,000 acres

Summary of Physical, Bacteriological and Chemical Data for Surface Waters of Lake Michigan

- 1/ Data from records taken from joint study by the Bureau of Re September 1959); 1st line entry maximum concentration; 2nd l tion Control Board standards for Class "C" water
- 2/ Sampled July-September 1959 only
- 3/ Limiting value of 200 milligrams per liter adopted
- 4/ Letter and number in parenthesis refer to River and approxi

TABLE III-2

1, Bacteriological, and Chemical Quality Data
 Waters of Lower Bear River Basin

of	Dissolved Oxygen 2/	Biochemical Oxygen 2/ Demand BOD	MPN Coliform per 100 ml.	Total Iron Fe	Magnesium Mg	Sodium Na	Chloride Cl	Sulfate SO ₄	Hardness as CaCO ₃ 3/	Total Dissolved Solids
1	8.5	3.2	9,300	1.2	56	197	281	84	378	904
2	5.6	1.1	140	0.8	48	69	82	71	313	542
3			1	3	0		1	0	3	3
4			23,000	3.7	59	105	138	81	386	652
5			73	0.36	30	50	82	13	298	504
6			1	12	0		0	0	12	12
7	5.5	8.6	24,000	4.0	34	65	60	43	294	494
8	0.5	2.3	1,400	0.9	30	24	18	10	230	365
9			2	3	0		0	0	3	0
10	9.5	4.9	4,300	2.0	37	30	40	42	280	370
11	6.0	1.3	290	0.4	14	20	25	9	236	293
12			0	3	0		0	0	3	0
13	8.45	7.2	2,300,000+	6.8	41	35	48	30	448	877
14	5.55	1.4	43	0.57	9	7	8	5	145	201
15			7	15	0		0	0	13	2
16	7.7	6.3	230,000	5.0	58	86	116	86	372	610
17	5.8	1.9	73	0.7	26	15	45	35	238	358
18			6	15	0		0	0	15	11
19	8.3	6.0	43,000	12.0	44	26	28	44	284	385
20	5.5	1.0	230	0.52	8	8	12	16	209	255
21			1	15	0		0	0	15	0
22			1,400	1.63	56	72	85	76	354	593
23			93	0.79	23	48	58	32	237	398
24			0	5	0		0	0	5	3
25	9.3	3.5	9,300	2.3	54	190	290	74	347	865
26	6.8	1.3	93	0.41	21	31	41	27	231	330
27			2	15	0		2	0	15	9
28			23,000	3.65	59	213	329	78	364	993
29			23	0.70	29	31	45	35	245	353
30			1	7	0		3	0	7	5
31			2,300,000+	17.0	84	920	1,283	285	594	3,004
32			2,300	1.3	26	180	217	92	324	854
33			12	15	0		15	1	15	15
34	9.2		46,000	2.78	59	800	1,284	103	409	2,568
35	2.8		43	0.50	24	69	113	55	260	488
36			4	15	0		9	0	15	14

The Bureau of Reclamation, Region 4, and the Utah Water Pollution Control Board (July 1958 through
 entration; 2nd line entry minimum concentration; 3rd line entry months exceeding Utah Water Pollu-
 water

Adopted
 river and approximate river miles above mouth

In accordance with "The Standards of Quality and the Regulations for Water Classification," adopted by the Utah State Water Pollution Control Board, November 9, 1954, and amended September 7, 1960, those portions of the Bear River and its tributaries located in the State of Utah have been classified as follows:

Bear River from Utah-Idaho State line to Cutler Dam	Class C
Bear River from Cutler Dam to confluence with Malad River	Class C ₁
Bear River from confluence with Malad River to Mouth	Class D ₁
Cub River from Utah-Idaho State line to confluence with Worm Creek	Class C
Cub River from confluence with Worm Creek to Mouth	Class D
Worm Creek from Utah-Idaho State line to confluence with Cub River	Class D
Malad River from Utah-Idaho State line to Waste Outfall of Garland Plant of Utah-Idaho Sugar Company	Class C ₁
Malad River from Waste Outfall of Garland Plant of Utah-Idaho Sugar Co. to Mouth	Class D ₁
All other portions and tributaries to Bear River in Utah	Class C

All canals located in whole or in part in the State of Utah whose source of water is the Bear River or its tributaries shall bear the classification required of the water at point of diversion.

The standards of purity and regulations adopted by the Utah Water Pollution Control Board pertaining to the above classifications are found in Appendix "A."

Pertinent Data (2)

The potential plan of development provides for an increase in water supply for irrigation of lands in Idaho and Utah. In addition, the Honeyville Reservoir will provide a more uniform water supply to the Bear River Migratory Bird Refuge and also will divert water to the Willard Bay Reservoir in the Weber River Basin area.

Table III-3 displays pertinent data for the proposed reservoirs and canals.

TABLE III-3

Proposed Reservoirs and Canals (1)Bear River Project

<u>Features</u>	<u>Proposed Reservoirs</u>			
	<u>Oneida Narrows</u>	<u>Honeyville</u>	<u>Glendale</u>	
Stream	Bear River	Bear River	Worm Creek	
Approximate River Miles Above Mouth	78	24	B62-C8-12	
Type of Dam	Earth and Rockfill	Earth	Earth and Rockfill	
Elevations-ft. MSL:				
Normal water surface	4,928	4,275	4,990	
Seasonal pool	4,915	4,259	--	
Minimum pool	4,885	4,236.5	--	
Area - Acres:				
Normal water surface	8,900	3,630	630	
Seasonal pool	7,500	3,000	--	
Minimum pool	1,850	1,445	--	
Volumes - Acre-feet:				
Active capacity	225,000	104,800	22,000	
Inactive capacity	150,000	15,200	1,000	
Total capacity	375,000	120,000	23,000	
Canals and Conduits:	<u>Oneida</u>	<u>Honeyville</u>	<u>Cub-Worm</u>	<u>East Cache</u>
Initial Capacity	1,380	250	382	432
(sec.ft.)				
Length (miles)	104.8	19.4	7.0	27.0

IV. DESCRIPTION OF STUDY AREA

Location and Boundaries

The study area is located in the southeastern portion of the State of Idaho and the extreme north-central portion of the State of Utah. The area under consideration is shown on Figure 1. The five counties studied are Caribou, Franklin and Oneida in Idaho; Box Elder and Cache Counties in Utah.

Physiography (3)

Bear River and many of its tributaries, which will provide the project water supply, are bordered on the west and north by the Snake River drainage basin and on the east by the Green River Watershed, a tributary of the Colorado River. Bear River is the largest tributary of the Great Salt Lake and is the Western Hemisphere's largest stream that does not reach the ocean. Bear River originates high in the Uinta Mountains in Utah and flows generally north, turning west in Idaho and thence south to the Great Salt Lake.

Geology (3)

The Great Basin, in which the Bear River Project is located, was at one time relatively level and formed part of a great ocean basin. In later geologic ages, erosion and sedimentation occurred, forming fan, delta and embankment deposits. The relatively recent sediments deposited by Quaternary Lake Bonneville comprise the major part of the soil materials upon which the Bear River Project's East Cache, West Cache and Malad River area lands are located. In the Grace area there is evidence of several periods of volcanism. This activity resulted in large quantities of fluid lava fanning out over the major part of the valley floor, along with wind transported materials which blanketed the area.

Soils (3)

Soils of the Bear River Project area have been developed from locustrine, alluvial and loessial parent materials. A semiarid climate was a controlling influence under which these soils were developed. Under low rainfall conditions, only limited leaching of soil nutrients has occurred, as is evidenced by a weak lime zone in the subsoil. The various geologic formations have resulted in a wide variation in the soils. Soil profile conditions such as indurated zones, lime hardpans, or travertine are rarely encountered.

Climate (3)

The project lands have a temperate, semiarid climate with relatively warm summers and cold winters. The annual precipitation on the project lands average about 15 inches. The mean annual temperature for Gem, Cache and Malad Valleys is about 49° F with extreme temperatures ranging from a minimum of -40° to a maximum of 108°. The mean annual temperature of the Great Salt Lake Valley is about 48° F with extremes ranging from -25° to 104°F. The annual frost-free period averages about 120 days in Gentile, Cache and Malad Valleys and about 150 days in the Great Salt Lake Valley.

Transportation Facilities (3)

U. S. Highways 89, 91, 191, 30N and 30S, all transcontinental routes, traverse the project area. Numerous bituminous-surfaced state and county highways link the area with the transcontinental routes. Several trucklines serve the area and railheads are established at a number of points. A commercial airport operates at Logan, Utah, while a number of smaller towns operate airports and landing strips for private air transportation.

Communication service is provided by the Mountain States Telephone and Telegraph Company and electrical service by the Utah Power and Light Company. Virtually all of the communities have grade schools and the larger communities have high schools. Utah State University is located at Logan.

V. ECONOMICS AND POPULATION

Economic Base

Irrigated agriculture, the principal industry in the project area, accounted for 20 percent of total industrial employment in 1960. Dairying provides the largest source of farm income followed by sales of beef cattle and sheep. Processors of agricultural products include: milk and milk product plants, sugar beet factories, vegetable canneries, and poultry processing plants. Trading centers are located at Malad, Soda Springs, Grace, and Preston in Idaho; Brigham City, Logan, Smithfield, and Tremonton in Utah.

Small sawmills are operated on forest lands. Mining of phosphate rock for processing into fertilizer is the principal mineral industry. Employment in forestry and mining amounted to less than 1 percent of the total in 1960.

Manufacturing comprised 18 percent of total industrial employment in 1960. Production of non-durable goods, such as apparel mill products, has increased rapidly due to an abundance of relatively cheap labor. The Thicokol Chemical Corporation plant near Brigham City, Utah, has provided employment for residents of Brigham City and Tremonton since its construction in 1956.

Service industries such as construction, transportation, communications, utilities, retail and wholesale trade, public administration, and personal services amounted to 62 percent of total industrial employment in 1960. Table V-1 shows trends in total industrial employment and proportion employed in each industry from 1940 to 1960.

Recreation is also an important consideration on forest lands. Mountain streams and man-made reservoirs provide recreation in the form of good trout fishing, while the mountainous areas provide excellent hunting for deer, elk and small game.

Population

The population is centered in the valley areas and principally in those sections where irrigation farming has been developed. The proposed project area encompasses the populated areas of Caribou, Franklin, and Oneida counties in Idaho; Box Elder and Cache counties in Utah. Most of the increase in population from 1940 to 1960 has occurred in Box Elder and Cache counties. Logan, Utah, is the largest community in the area.

TABLE V-1

Total Industrial Employment and Proportion Employed in Each Industry for Utah, Idaho
and Five Counties of the Lower Bear River Basin, 1940-60 (11)

Item	State of Utah		Five Counties Lower Bear River			State of Idaho		
	1940	1950	1940	1950	1960	1940	1950	1960
Total Indust. Employ.								
Number	148,386	228,822	16,665	22,505	26,633	158,506	206,002	232,858
Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Agric., Forestry & Fish.								
Number	28,960	28,770	7,456	8,023	5,265	58,697	56,083	44,253
Percent	19.5	12.6	44.8	35.7	19.8	37.0	27.2	19.0
Mining								
Number	10,102	12,081	169	162	62	6,735	5,374	4,197
Percent	6.8	5.3	1.0	0.7	0.2	4.3	2.6	1.8
Manufacturing								
Number	16,479	28,267	1,060	1,418	4,853	12,569	19,234	31,443
Percent	11.1	12.3	6.4	6.3	18.2	7.9	9.3	13.5
Construction								
Number	8,123	16,983	831	1,459	1,901	7,247	15,510	15,826
Percent	5.5	7.4	5.0	6.5	7.1	4.6	7.5	6.8
Transportation								
Number	11,232	15,656	465	590	442	7,598	12,700	11,406
Percent	7.6	6.8	2.8	2.6	1.7	4.8	6.2	4.9
Comm. and Utilities								
Number	4,500	6,639	315	592	667	3,310	6,188	6,563
Percent	3.0	2.9	1.9	2.6	2.5	2.1	3.0	2.8
Retail & Wholesale Trade								
Number	28,766	46,379	2,410	3,687	4,462	25,974	39,295	47,200
Percent	19.5	20.3	14.4	16.4	16.8	16.4	19.1	20.3
Services								
Number	33,840	52,594	3,350	5,311	7,361	31,094	43,777	61,190
Percent	22.8	23.0	20.1	23.6	27.6	19.6	21.3	26.3
Public Administration								
Number	6,384	21,453	609	1,263	1,620	5,282	7,841	10,780
Percent	4.3	9.4	3.6	5.6	6.1	3.3	3.8	4.6

Trends in population characteristics from 1940 to 1960 are given in Table V-2. Urban-rural population proportions and median income per family for the project area are more comparable to Idaho than to Utah.

Future Growth

The census data for 1940, 1950, and 1960 were used as a guide in projecting the growth pattern of population for 1970 to 2060. Comparable data were not obtainable prior to 1940. Basic assumptions include:

1. No major war, epidemic, severe economic depression, or other catastrophe.
2. Relatively high employment and relatively high economic activity.

The projected compound rate of growth for the project area is expected to be lower than the rate for Utah, the United States, and Idaho in that order. The primary reasons are the somewhat isolated location and the lack of many natural resources in the area.

With construction of the project, considerable increase in agricultural production would result. However, greater efficiency in crop and livestock production is expected to offset additional labor requirements for the increased production by 2060. Other extractive industries are not expected to become important.

The labor force requirement for manufacturing industries is expected to increase proportionately to the total labor force by the year 2060, particularly in the non-durable goods such as food and kindred products, and apparel mill products.

Construction will gain in importance with the building of the project and will maintain a higher level than at present. Power and fuel are expected to decrease in relative importance.

Transportation, communications, utilities, retail and wholesale trade, public administration, and personal services will increase in proportion to total industries. A greater proportion of the total labor force will be employed in dependent industries in 2060 than in 1960. Likewise, a lesser proportion will be employed in basic industries. Table V-3 shows the population and labor force for the project area for 1960 and the projections for 1985, 2010 and 2060.

TABLE V-2
Population and Labor Force Characteristics of Utah, Idaho and the
Five Counties of the Lower Bear River Basin, 1940-60 (11)

Item	State of Utah			Five Counties Lower Bear River			State of Idaho		
	1940	1950	1960	1940	1950	1960	1940	1950	1960
Total Population									
Number	550,310	688,862	890,627	66,559	73,100	78,885	524,873	588,637	667,191
Percent	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Rural - Non-farm									
Number	150,465	158,367	180,058	16,476	19,270	26,594	148,149	171,128	217,312
Percent	27.3	23.0	20.2	24.8	26.4	33.7	28.2	29.1	32.6
Rural - Farm									
Number	94,352	80,620	43,411	25,607	23,448	15,680	200,016	164,960	132,782
Percent	17.1	11.7	4.9	38.5	32.1	19.9	38.1	28.0	19.9
Urban									
Number	305,493	449,855	667,158	24,476	30,382	36,611	176,708	252,549	317,097
Percent	55.6	65.3	74.9	36.7	41.5	46.4	33.7	42.9	47.8
Population (14 yrs & over)									
Labor Force	389,086	469,811	571,533	45,485	49,411	51,490	384,890	411,951	447,392
Armed Forces	181,244	243,054	318,600	20,003	23,327	27,640	191,196	218,309	251,138
Civilian Labor Force	0	1,567	3,402	0	39	37	0	414	4,299
Percent of Total Pop	181,244	241,487	315,198	20,003	23,288	27,603	191,196	217,895	246,839
Employed	32.9	35.2	35.4	30.1	31.9	35.0	36.4	37.0	37.0
Unemployed	148,386	228,822	302,147	16,665	22,505	26,633	158,506	206,002	232,858
Percent	32,858	12,665	13,051	3,338	783	970	32,690	11,893	13,981
Not in Labor Force	18.1	5.2	4.1	16.7	3.3	3.5	17.1	5.5	5.7
(14 yrs & over)									
Population under 14 yrs	207,842	226,757	252,933	25,482	26,084	23,850	193,694	193,642	196,254
Total Population not in	161,224	219,051	319,094	21,074	23,689	27,395	139,983	176,686	219,799
Labor Force									
Non-Worker/Worker Ratio	369,066	445,808	572,027	46,556	49,773	51,245	333,677	370,328	416,053
Median Income per Family	2.04	1.83	1.80	2.33	2.13	1.85	1.75	1.70	1.66
Not given	Not given	\$3,001	\$5,899	Not given	\$2,434	\$5,346	Not given	\$2,685	\$5,259

TABLE V-3

Population and Labor Force, Bear River Project Area
1960 and Projections for 1985, 2010 and 2060

Item	1960	1985	2010	2060
Civilian Labor Force	27,603	34,720 ^{1/}	44,275 ^{1/}	74,270 ^{1/}
Employed	26,633	32,984	42,061	70,556
Unemployed	970	1,736 ^{2/}	2,214 ^{2/}	3,714 ^{2/}
Armed Forces	37	0	0	0
Total Labor Force	27,640	34,720	44,275	74,270
Not in Labor Force	51,245	64,480	82,225	137,930
Total Population	78,885	99,200	126,500	212,200

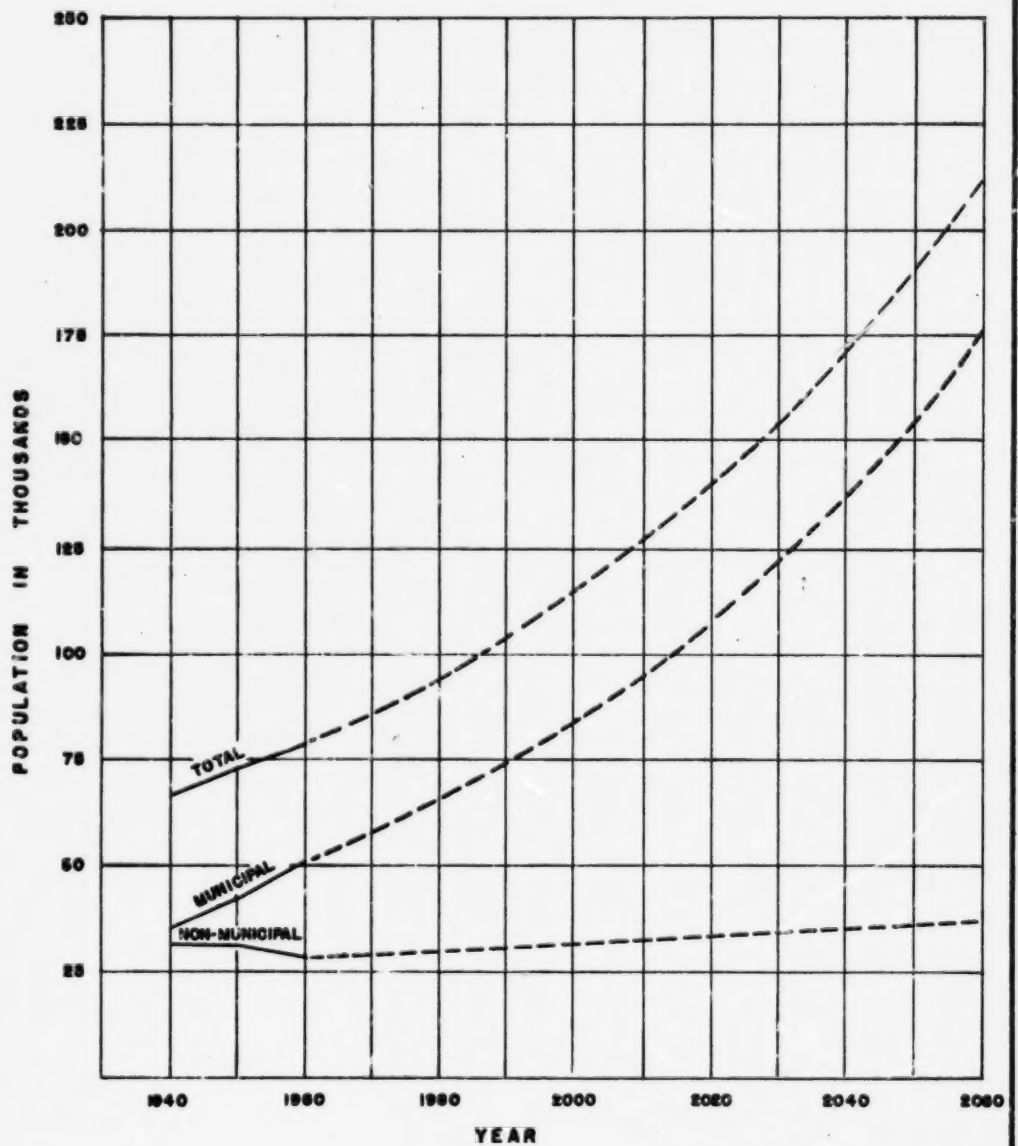
^{1/} Total civilian labor force assumed to be 35 percent of total population in forecasting total population

^{2/} The unemployment rate was assumed to be 5 percent for forecasting purposes

Population was divided into municipal and non-municipal categories to obtain a more accurate estimate of water requirements. Municipal population includes all towns and cities with 1000 or more persons. Non-municipal population includes all other persons in the project area. Figure 2 shows the present and projected distribution of population.

Total population in 2060 is expected to be 268 percent of the 78,885 persons in 1960. Municipal population in 2060 will be about 341 percent of 1960, while non-municipal will be about 129 percent.

Development of the water resources in the area may enhance the respective watersheds as sites for camping, picnicking and boating. Recreational use of the reservoirs would complement existing recreation areas.



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BEAR RIVER PROJECT

POPULATION

DEPARTMENT OF HEALTH, EDUCATION, & WELFARE
PUBLIC HEALTH SERVICE
REGION VIII DENVER, COLORADO

FIGURE 2

VI. WATER REQUIREMENTS

Present Water Use

Municipal

Municipal water needs include residential, public, commercial and industrial needs which are served by organized municipal water systems and are reflected in a per capita use figure. Industrial water use is presently supplemented by individual wells as described in the following section.

Industrial

Industrial water needs are generally served by organized municipal water systems, however, these industrial water needs are, in some cases, supplemented by industry owned wells during peak demands. Quantitative information on these additional well supplies are not available at this time.

Existing Sources

Quantity

On the basis of information obtained from the communities, the average daily per capita water consumption ranges from 80 to 960 gallons with the maximum daily per capita use of 3300 gallons. In the latter case, industrial water requirements are responsible for the high per capita use figure. These values were computed from estimated total water usage supplied by the community officials. Table VI-1 summarizes present water supply data for the communities in the Lower Bear River Basin.

Quality

A summary of the chemical quality of the existing public water supplies is shown by Table VI-2.

Additional Water Needs

Municipal and Industrial

Municipal, including industrial, water demand for the study area were estimated for the years 1985, 2010, and 2060 by multiplying the projected municipal and industrial population by a projected per capita demand figure of 250 gallons per capita per day (gpcd). The present average per capita water use figure for the study area as a whole, is approximately 375 gpcd. For the purpose of this study, the figure of 250 gpcd was selected as a more reasonable per capita consumption assuming that by the installation of water meters and the initiation of a more realistic water rate schedule, promiscuous waste would be reduced.

Table VI-1

Existing Public Water Supplies

Community	Estimated population served	Source ^{1/}	Treat- ment ^{2/}	Water usage	
				Annual (acre-feet)	Daily (gpcd) ^{3/}
<u>Idaho</u>					
Clifton	225	Sp, W	N	135	535
Dayton	450	Sp	N	90	180
Downey	800	Sp, W	N	395	440
Franklin	800	Sp	N	225	250
Grace	760	Sp, W	N	560	660
Lava Hot Springs	700	Sp, W	N	110	145
Malad City	2,400	Sp, W	Cl	1,135	420
Preston	4,500	Sp	Cl	3,280	650
Soda Springs	2,450	Sp	N	2,700	960
Weston	390	Sp	N	112	260
<u>Utah</u>					
Amalga	190	W	N	220	865
Bear River City	460	Sp	N	480	940
Bothwell	250	Sp, W	N	65	230
Brigham City	10,200	Sp, W	Cl	6,080	535
Clarkston	490	Sp	N	123	225
Corinne	440	Sp	N	40	80
Cornish	210	Sp	N	81	345
Deweyville	230	Sp	N	65	250
Fielding	230	Sp	N	80	250
Garland	1,050	Sp	Cl	138	115
Honeyville	600	Sp	N	260	385
Hyde Park	660	Sp	N	364	490
Lewiston	1,530	Sp	Cl	1,125	660
Logan	19,100	Sp	Cl	13,730	345
Millville	350	Sp	N	112	280
Newton	490	Sp	N	145	260
North Logan	660	Sp	N	152	205
Plymouth	170	Sp	N	100	530
Portage	160	Sp, W	N	25	140
Providence	1,100	Sp	N	360	290
Richmond	1,050	Sp	Cl	216	185
River Heights	740	W	N	107	130
Smithfield	2,470	Sp	Cl	1,165	420
Tremonton	1,900	Sp	Cl	455	215
Trenton	450	Sp	Cl	157	250
Wellsville	1,240	Sp	N	--	--

^{1/} Sp - Spring(s)

W - Well(s)

^{2/} N - None

Cl - Chlorination

^{3/} gpcd - Average gallons per capita per day

TABLE VI-2

Chemical Analysis of Public Water Supplies*

(Data obtained from Idaho and Utah State Health Departments)

Community	Total Dissolved Solids	Total Hardness	Iron	Calcium	Magnesium	Sodium	Chlorides	Sulfates	Fluorides	Nitrates
<u>Idaho</u>										
Clifton <u>1/</u>	304	256	0	65	23	0	10	20	0.1	-
Dayton <u>1/</u>	236	192	0.02	53	15	7	10	12	0	0
Downey <u>1/</u>	252	231	0.07	58	21	-	5	-	0	-
Franklin <u>1/</u>	212	164	0	45	13	21	7	5	0	1.5
Grace <u>1/</u>	456	216	0.05	65	13	5	4	10	0.1	-
Grace <u>2/</u>	492	335	0.05	70	39	50	38	64	0.3	-
Lava Hot Springs <u>1/</u>	236	198	0.14	42	23	1	12	5	0.05	0
Lava Hot Springs <u>2/</u>	361	270	0	62	28	11	14	11	0	0
Malad City <u>1/</u>	286	188	0.04	49	16	25	26	19	0.2	1.8
Preston <u>1/</u>	174	154	0.12	41	13	3	3	4	0	-
Soda Springs <u>1/</u>	398	318	0	60	41	8	2	17	0.1	0.4
Weston <u>1/</u>	522	320	0	77	31	16	25	21	0.2	2.4
<u>Utah</u>										
Amalga <u>2/</u>	255	213	0.10	48	23	17	19	10	0.25	-
Bear River City <u>1/</u>	217	193	0	44	21	7	11	14	0	-
Bothwell <u>3/</u>	410	245	0	75	14	38	61	35	0.3	8.0
Brigham City <u>1/</u>	233	202	0	45	22	6	13	10	0.2	2.2
Brigham City <u>2/</u>	243	207	0.1	50	20	7	11	15	0.15	4.0
Clarkston <u>1/</u>	272	241	0	58	24	10	16	8	0.15	0
Corinne <u>1/</u>	251	231	-	49	27	11	9	18	0	-
Cornish <u>1/</u>	918	500	0	110	55	134	186	206	0	13.3
Deweyville <u>1/</u>	162	196	0	42	22	1	6	5	0.3	2.2
Fielding <u>1/</u>	394	271	0	85	14	32	41	33	0.3	39.8
Garland <u>1/</u>	415	235	0.1	54	25	69	82	32	0.1	-
Honeyville <u>1/</u>	233	208	0.2	47	22	7	11	14	0	-
Hyde Park <u>1/</u>	202	178	0.15	48	14	5	7	7	0.1	-
Lewiston <u>3/</u>	154	168	0	36	19	2	3	18	0	0.13
Logan <u>3/</u>	193	189	0.06	47	17	1	2	3	0	0.27
Millville <u>1/</u>	275	239	0	55	25	9	14	25	0.1	0
Newton <u>1/</u>	363	256	0	68	25	20	19	25	0.2	2.5
North Logan <u>1/</u>	258	252	0	54	30	7	17	4	0	0.44
Plymouth <u>1/</u>	305	248	0	58	25	9	14	8	0.45	12.0
Portage <u>3/</u>	370	253	0	81	13	33	50	14	0.2	-
Providence <u>1/</u>	200	178	0	46	16	7	11	14	0.5	0
River Heights <u>2/</u>	283	245	0.25	65	20	7	10	12	0.2	-
Smithfield <u>2/</u>	341	280	-	76	22	9	9	7	0	7.6
Tremonton <u>2/</u>	307	206	0	61	14	26	36	13	0.3	7.6
Trenton <u>2/</u>	347	268	0.2	61	24	18	25	16	0.1	3.4
Wellsville <u>1/</u>	262	222	0	58	19	10	15	9	.025	-

*All analysis in parts per million

1/ Springs2/ Wells3/ Wells and spring water from distribution system

The municipal and industrial water demand for the study area is 24.9 million gallons per day (mgd) projected to the year 1985; 31.6 mgd projected to the year 2010; and 53.1 mgd projected to the year 2060.

Based on available information on the ground water supplies, ^{1/} future municipal and industrial water requirements could be met by using surface waters, providing the total dissolved solids (TDS) of 1000 parts per million (ppm) is acceptable. Through exchange agreements between the communities and the irrigators additional culinary water could be obtained from the high mountain springs.

Stream Quality Maintenance

Under provisions of the Federal Water Pollution Control Act, Public Law 84-660, as amended by Public Law 87-88, in the survey or planning of a reservoir by any Federal agency, consideration must be given to the inclusion of storage for regulation of streamflow for the purpose of water quality control. It is expressly stated that any such storage and water releases shall not be provided as a substitute for adequate treatment or other methods of controlling wastes at their sources.

Discharge of wastes, even when treated to the maximum economically feasible and practical limit, will cause an unsatisfactory quality condition in receiving waters whose waste assimilation capacity is exceeded. This condition occurs during periods of low flows and may be avoided by the addition of water to maintain flows at higher levels. It is essential that recognition be given to the

^{1/} Because of the many differences in the soil material deposits in the Lower Bear River Basin, ground-water levels are variable. Over the central lowlands, the ground-water level in general is around five feet below the ground surface. On the valley slopes and benches ground water lies 30 to 150 feet or more below ground surface. An artesian basin underlies an area of lowlands and lower valley slopes between Logan and Richmond, Utah. This basin is useful as a source of water for irrigation and other purposes, but aggravates drainage difficulties on some of the lands in the area if not controlled.

Except for the water in the artesian basin ground water is not available in sufficient quantity and quality to afford development of any substantial water supplies. Although the artesian basin is a potential source of additional water, it is considered by the Bureau of Reclamation, neither a practicable nor sufficient source for meeting the needs of eastern Cache Valley. (4) (5)

need for flows which must prevail in receiving streams if the quality of their waters is to be maintained at acceptable levels. The following criteria and/or conditions were used for estimating water quality control requirements:

1. That waste treatment facilities will remove 90 percent of the organic substances exerting a biochemical oxygen demand (BOD). In the absence of stream reaeration and other pertinent data, 2 parts of dillution water to one part of treated waste effluent is necessary to maintain optimum stream environment.
2. The effluent from treatment facilities will be uniformly mixed in the receiving stream.
3. The dissolved oxygen (DO) content in the stream will be 5 ppm or greater.
4. With total dissolved solids (TDS) of 1000 ppm being acceptable, chemical and physical characteristics will not exceed limits as described in the Public Health Service Drinking Water Standards.
5. In the Bear River Basin above Corinne, Utah, a 1:1 salt balance exists in irrigated areas; however, there is a pick-up of one ton of salts per irrigated acre in the Malad River basin.
6. Evaporation and seepage from streams are reflected in existing streamflow data, quantity and quality, and require no adjustment; but additional evaporation will result from project reservoirs.
7. Storage and/or regulated releases of industrial wastes will be arranged to accomplish optimum use of the surface water resources.

Waste disposal facilities in the study area may be generally described as unsatisfactory under present conditions. Table VI-3 lists present sources of municipal and industrial pollution.

Under Section 8 of the Federal Water Pollution Control Act, Public Law 660, enforcement action to abate the pollution in the Bear River and its tributaries is under way. The First Session of the Conference on Pollution of the Interstate Waters of the Bear River was held on October 8, 1958 and the Second Session on July 19, 1960.⁽⁶⁾ ⁽⁷⁾ On May 9, 1961, representatives of the States concerned and the Public Health Service agreed that abatement of Bear River pollution should be substantially effected by January 1, 1963. It is presently anticipated that this schedule of abatement will not be met and that a Third Session of the Conference will be called.

TABLE VI-3
Municipal and Industrial Wastes ^{1/}

Source	Estimated Sewered Population	Nature of Wastes	Treatment Provided	Estimated Population Equivalent of Wastes Discharged to Water Course
IDAHO				
Soda Springs	2,400	Municipal	Primary	720 Little Spring Creek to Bear River
Monsanto Chemical	75	Domestic	Septic Tank	65 Soda Creek to Bear River
Monsanto Chemical	-	Inorganic	Lagoon	2/ Soda Creek to Bear River
Grace	700	Municipal	Secondary	2/ Bear River
Cheese Factory	-	Organic	None	2/ Bear River
Thatcher Cheese Factory	-	Organic	None	2/ Bear River
Preston	3,640	Municipal	Primary	2,960 Worm Creek to Cub River
Whitney-Franklin	-	Beet Sugar	Lagoons	260,000 Worm Creek to Cub River (October-November)
County Sugar Co.	-	Vegetable Packing	Screens and Lagoons	17,800 Cub River (July-September)
Franklin-California Packing Co.	-			
UTAH				
Lewiston	1,336	Municipal	None	1,330 Cub River
Amalgamated Sugar Co.	-	Beet Sugar	Lagoons	400,000 Cub River (October-December)
			Trickling Filter & Clarifier	
Richmond, Sego Milk Co.	-	Dairy	None	1,000 Bear River
Sego Milk Co.	20	Domestic	Septic Tank	0 Subsurface Land Disposal
Amalga, Cache Valley Dairy Assoc.	-	Dairy	None	7,100 Bear River
Smithfield, California Packing Co.	-	Vegetable Packing	Screens	35,200 Irrigation Ditch (July-September)
Hyrum	-			
California Packing Co.	-	Veg. Packing	Screens	1,050 Little Bear River (July-September)
E. A. Miller Packing Co.	-	Slaughtering	None ^{3/}	3,100 Little Bear River
Tri-Miller Packing Co.	-	Slaughtering	None ^{3/}	1,700 Drainage Ditch to Little Bear River

TABLE VI-3 (Cont'd)
Municipal and Industrial Wastes 1/

Source	Estimated Sewered Population	Nature of Wastes	Treatment Provided	Estimated Population Equivalent of Wastes Discharged to Water Course
Wellsville	500	Municipal	None	500 Little Bear River
Morning Milk	-	Dry Milk	None	1,000 Little Bear River
Valley Rendering Co.	-	Rendering	Flotation <u>4/</u>	1,000 Drainage Ditch to Little Bear River
Logan	22,000	Municipal	None	22,000 Logan River
Utah By-Products	-	Organic	Septic Tank	150 Blacksmith Fork
IDAHO				
Malad City	2,000	Municipal	Lagoons	0 Deep Creek to Malad River
UTAH				
Garland	1,119	Municipal	None	1,120 Malad River
Utah-Idaho Sugar Co.	-	Beet Sugar	Screens & Pulp Drier	200,000 Malad River
Utah By-Products	-	Organic	None	600 Malad River
Bear River High School	1,200	Domestic	None	500 Malad River
Tremonton	2,115	Municipal	None	2,115 Malad River
Allen Meat Co.	-	Organic	None <u>5/</u>	250 Malad River
Bear River City	400	Municipal	None	(200 Malad River
Corinne	500	Municipal	None	(200 Bear River
				500 Bear River

1/ Listed in downstream sequence

2/ Undetermined

3/ Blood collected

4/ Lagoons under construction to follow flotation

5/ Discharge to land drains

For the purposes of this report, the assumption is made that as a result of the above mentioned enforcement action, pollution in the Bear River will be abated and adequate treatment facilities installed.

Irrigation of 483,000 acres of basin lands accounts for the depletion of the Bear River by an estimated 652,000 acre-feet annually. Based on mean annual flow of 1,221,000 acre-feet at Corinne, Utah, during 1949-57, this amounts to a mean annual reduction in flow of about 25 percent. Estimates indicate that this reduction in flow has been responsible for increasing the concentrations of total dissolved solids at Corrine by about 53 percent.⁽²⁾

Table VI-4 shows the concentration of total dissolved solids, annual salt load carried in the Bear River, and streamflow under both present and proposed stream regimen. The concentration of total dissolved solids and the annual salt load under proposed stream regimen were determined using a weighted mean annual concentration.

As the soil in the Malad River Basin is high in soluble salts,⁽²⁾ the irrigation return flows from the irrigated areas will be unsuitable for many other uses. A single-purpose use of our water resources is not desirable. Future use of the water resources in the Bear River Project should be sufficiently flexible to maximize the choice of water use for the majority of the people affected. However, at this time, there appears to be no additional beneficial use of the available water supply below the potential irrigation area.

Calculations based on the above assumptions and criteria, indicate there is no need to store water for the purpose of streamflow regulation for water quality control at this time, as there are no apparent or anticipated users requiring a higher quality water than would be obtained under project operation.

TABLE VI-4

Concentration of Total Dissolved Solids and Annual Salt Load ^{1/}

Location	Total Dissolved Solids		Annual	
	Weighted Annual Mean (PPM)	Tons per Acre-foot	Flow (Acre-feet)	Salt Load (Tons)
	<u>Present</u>		<u>Present</u>	
Bear River at ^{2/} Oneida, Idaho	440	0.60	564,000	338,000
Bear River at ^{3/} Cutler Dam, Utah	450	0.61	1,171,000	715,000
Bear River at ^{4/} Corinne, Utah	1,340	1.82	1,221,000	2,220,000
	<u>With Project</u>		<u>With Project</u>	
Bear River at ^{2/} Oneida, Idaho	440	0.60	564,000	338,000
Bear River at ^{3/} Cutler Dam, Utah	521	0.71	899,000	639,000
Bear River at ^{4/} Corinne, Utah	1,500	2.04	1,091,000	2,220,000

^{1/} Maximum, minimum and seasonal variations are not reflected in this table.

^{2/} Bear River at Oneida, Idaho - nearest gaging station on the Bear River above project area. Water quality at this location will not be affected by the proposed project.

^{3/} Bear River at Cutler Dam - intermediate point within the project area.

^{4/} Bear River at Corinne - lowest gaging station on the Bear River. (Gaging station discontinued in 1957.) Full effect of project development on water quality will be apparent at this location.

VII. BENEFITS OF STORAGE

Water Supply Benefits

If future municipal water demands are to be met by surface waters, the following benefits would accrue through improved quality due to savings of soap, detergents, and general household cleansers from the reduction of hardness:

1. Benefits discounted to present annual values, from improved water quality for municipal water supplies from Oneida Reservoir will average \$2,500 annually; and
2. Benefits discounted to present annual values, from improved water quality for municipal water supplies from Cutler and Honeyville Reservoirs will average \$11,200 annually.

Water Quality Maintenance Benefits

There is no apparent need for storage in the project reservoirs for regulations of streamflow for the purpose of water quality control and therefore, no benefits are attributed to this purpose. However, benefits will result from improvements in water quality through storage by the reduction of hardness as indicated in the preceding section, Water Supply Benefits.

PART 2 - PUBLIC HEALTH ASPECTS

I. PUBLIC HEALTH AND RELATED PROBLEMS

Summary

Mosquitoes are the principal vectors which might be affected by the project. Several species of mosquitoes having a public health significance may be produced in large numbers in the area when suitable aquatic habitats are present. Encephalitis, commonly known as sleeping sickness or brain fever, is the most important mosquito-borne disease in the area. During the period 1939 through 1955 equine encephalitis occurred during 15 years of the 17-year period. The most recent epidemic of encephalitis occurred during the late summer and fall of 1958 with 48 laboratory-confirmed human cases centered near Bothwell, Utah. This was the largest outbreak of this disease among humans in the history of the state.

The production of mosquitoes and other aquatic insects of public health importance is widespread in many irrigation areas. Man-made mosquito breeding areas are frequently caused by the same faulty irrigation and drainage practices that cause serious soil and water problems. Improved soil and water management practices will help to prevent and minimize mosquito sources.

Recommendations

As overall watershed management may involve many interests, it is essential that developments and activities on a watershed pertaining to public health aspects be coordinated with State and/or local health authorities. To minimize the potential public health hazards that may be associated with development of the Bear River Project, it is recommended that the following be given due consideration.

General

1. That the water users' organization (i.e., Water Conservancy District) operating as the general administrative and contracting agency for the project should:
 - a. Alert all water users of the potential public health hazards associated with using inadequately treated canal water for culinary purposes;

- b. Exert all possible precaution to exclude sewage effluents and barnyard drainage from project canals, laterals, and drains;
 - c. Wherever and whenever possible assist the project inhabitants and communities in development of
 - (1) Approved water supplies, and
 - (2) Approved sewerage and sewage treatment facilities; and
 - d. Operate and maintain project facilities in accordance with established criteria.
- 2. That potential recreational areas be investigated and at least minimum water and sanitary facilities be provided in accordance with State Health Department regulations.
 - 3. That a sanitary survey of proposed construction campsites be made to eliminate potential health hazards.
 - 4. That all construction camps be provided with safe and adequate water supply and the required sanitary facilities in accordance with State Health Department requirements.
 - 5. That all effort be extended during construction stages, including land leveling and clearing, to exclude excess silt and debris from the water courses.
 - 6. That the Idaho State Department of Health and the Utah State Department of Health be kept currently informed regarding changes in plans and proposed construction schedules so that guidance and consultation may be provided on public health problems that may be encountered.

Insect Vector Control

In order to minimize public health hazards, every possible effort should be made to avoid creating conditions which will result in an increase in population of mosquitoes, and other arthropods and rodents of public health significance.

Responsibility for vector prevention and control is normally associated with land ownership or operating rights. Therefore, the agency, group, or individuals responsible for various aspects of the proposed project should be prepared to accept full responsibility for the prevention and control of vector problems resulting from the design, construction, operation, or maintenance of the project.

Reservoirs

1. Borrow areas resulting from construction of the dams should be located where they will be permanently inundated, if possible. Those located in the normal summer fluctuation zones or outside the reservoir basins should be made self-draining.
2. Adequate drainage should be provided for all potential ponding areas behind railway and highway embankments. Potential ponding areas located in the normal fluctuation zones should be connected to the reservoirs by drains to insure complete drainage or fluctuation with reservoirs. Those located outside the reservoir basins should be made completely self-draining.
3. Prior to impoundage, each reservoir basin should be prepared as follows:
 - a. The normal summer fluctuation zone of the permanent pool should be completely cleared except for isolated trees and sparse vegetation along abrupt shorelines or in the deeper portions of the pool which will be exposed to wave action. Intolerant timber located above the normal clearing line which will be killed by intermittent flooding should be removed. Standing timber left in the deeper parts of the reservoir where it will be completely submerged at minimum normal pool level is unimportant from the standpoint of mosquito control. Timber rooted below the minimum normal pool level but extending above that elevation may be felled and securely anchored in lieu of disposal. This practice sometimes has advantages for fisheries management.
 - b. All depressions, marshes, and sloughs which will be flooded by the reservoir at maximum pool level and which will retain water at lower pool levels should be connected with the reservoir by drains to insure complete drainage or fluctuation of water within the depression.
4. After impoundage, the following maintenance measures should be carried out in all potential mosquito-producing areas located within flight range of human population groups or recreational areas frequented by significant numbers of persons:
 - a. All dense vegetation should be removed periodically from flat, protected areas within the normal summer fluctuation zones by mechanical or chemical measures.

- b. Vegetation, debris, and flottage should be removed periodically from all drains to insure free flows.
 - c. Drains should be installed to adequately drain seepage areas that develop below the dams.
5. Water level management to minimize conditions favorable for mosquito production should be used to the maximum degree permitted by the primary purposes of the reservoirs. This will minimize the need for repetitive measures for controlling vegetation and mosquito production.
 6. As a general principle, waterside recreational areas, particularly those which have facilities for overnight occupancy, should be located along sections of reservoirs which have a low production potential for mosquitoes and other aquatic insects.

Irrigation Conveyance and Distribution System

1. Lining or other satisfactory seepage control measures should be provided for all sections of canals and laterals located in porous material where excessive leakage would result in waterlogged areas, seeps, and ponds.
2. Drains should be installed to prevent ponding of excess irrigation water and natural runoff along the upper side of canals and laterals. All drainage crossing or inlet structures should be placed on grade to avoid ponding.
3. All borrow areas should be self-draining to keep them from retaining ponded water. When possible, additional earth needed for embankments or fills should be obtained from high ground, thereby eliminating borrow areas adjacent to canals or laterals.
4. Where possible, provision should be made to prevent turn-outs and other hydraulic structures from retaining residual water when they are not being used.
5. Effective measures should be provided to prevent ponding of leakage from water control structures.
6. Every effort should be made to establish delivery schedules which will provide farmers with adequate but not excessive amounts of water at proper intervals to insure efficient irrigation of the crops concerned.
7. Vegetation and debris which retard normal flows should be periodically removed from all conveyance channels, water control structures, and drains.

Project Drainage System

1. Trunk drainage systems should be installed to insure complete removal and proper disposal of excess irrigation water, natural runoff, and seepage from both irrigable and nonirrigable lands affected by the distribution and use of irrigation water on the project.
2. Drainage ditches should be designed, constructed, and maintained so as to minimize ponding in the channels and to insure free flows at all times.
3. Provision should be made to prevent water from ponding behind spoil banks.
4. Underdrains, culverts, inlets, etc., should be placed on grade to prevent ponding.

Terrestrial Arthropods and Rodents at Recreation Areas Associated with Reservoirs

1. Proper storage, collection, and disposal of refuse should be practiced in order to prevent and control flies, wasps, other noxious insects, rats, wild rodents, and other small mammals.
2. All buildings should be rodentproofed at recreational areas where rodents are prevalent which may create public health hazards.
3. Debris, rubbish, and other materials which may serve as harborage for rodents and other small mammals should be removed periodically.
4. Brush and weeds along paths, trails, roadways, and other areas of frequent use by visitors should be removed in order to reduce the likelihood of tick infestation.

Supplemental Chemical Control Measures

In situations where adequate vector control is not obtained through the prevention and source reduction measures outlined above, provision should be made for supplemental use of insecticides and rodenticides to achieve the desired level of control.

Technical Assistance

In the event that vector problems arise in connection with the proposed Bear River Project, technical assistance may be obtained from the respective State Department of Health and the U. S. Public Health Service.

Public Health Services

Project development will improve the economy of the area so that local residents benefiting either directly or indirectly will be in a position to enjoy a higher standard of living. Among other necessities, this involves the establishment of a healthful environment. Some of the more important factors involved in creating such an environment include the development of safe and ample culinary water supplies, proper waste disposal facilities, and insect and rodent control measures.

Public health services are provided in the project areas by the Utah State Department of Health and the Idaho State Department of Health in Salt Lake City, Utah, and Boise, Idaho respectively.

Recreational Development

Development of the water resources in the area may enhance the respective watersheds as sites for camping, picnicking, boating, and swimming. However, the proximity of other established reservoirs and desirable mountain recreational areas will tend to keep the recreational use of project reservoirs to a minimum. The mountain settings of Cache and Caribou National Forests are very popular areas for recreation. The extent of recreational development, planned or spontaneous development, immediately contiguous to reservoirs will be regulated by the topographical features of the shoreline. Also, a receding shoreline during irrigation season, together with an accumulation of mud deposits above the water level, will create hazardous and undesirable conditions for some water-based recreational activities.*

In development of recreational areas at least minimum water and sanitary facilities should be provided to eliminate potential public health hazards. Construction, operation, and maintenance of these facilities should meet the requirements of the health department having jurisdiction. Protective fencing of restricted or hazardous areas and well-placed regulatory signs would be desirable.

*August 6, 1959, the Utah State Board of Health unanimously adopted the following statement:

"The State Department of Health recommends against swimming in streams and impoundments in the State of Utah, since these facilities do not lend themselves to proper protective control under conditions of utilization for public swimming purposes. Public swimming should be restricted to properly designed and operated artificial swimming pools."

Construction Phase of Project

Limited housing accommodations are available in the vicinity of construction sites to serve the contractor's employees during the construction phase of the project. Under these conditions a temporary construction camp may be necessary. Prior to final selection of a camp site a sanitary survey of the area should be made by the State Department of Health or the Public Health Service to assist in solving of problems which may be encountered in connection with the installation of water and sanitary facilities.

Water supplies and sanitary facilities required in connection with temporary construction camps and with permanent housing for reservoir attendants should comply with the requirements of the respective health department having jurisdiction so as to eliminate potential health hazards.

Mosquito and Other Vector Problems

Mosquitoes are the principal vectors which might be affected by the proposed project. Several species of mosquitoes of public health importance may be produced in large numbers in the area when suitable aquatic habitats are present. Encephalitis, commonly known as sleeping sickness or brain fever, is now the most important mosquito-borne disease in the United States and the area in which the proposed project is located. Mosquitoes transmit the encephalitis viruses among birds and from them to humans and horses. There are no effective chemotherapeutic measures for preventing or treating human cases, and some individuals, particularly children, who recover from encephalitis often suffer permanent mental disability.

In past years, outbreaks of encephalitis have occurred among both horses and humans in several areas in northern Utah. Records of the U. S. Department of Agriculture show that equine encephalitis cases occurred in the area of the proposed project (Box Elder and Cache Counties, Utah, and Caribou, Franklin and Oneida Counties, Idaho) during 15 years of the 17-year period, 1939 through 1955, for which records are available. The most recent epidemic of encephalitis occurred in northern Utah during the late summer and fall of 1958 and involved both humans and horses. This epidemic, involving 48 laboratory-confirmed human cases, centered near Bothwell, Box Elder County, was the largest outbreak of this disease among humans in the history of the State. Antibody surveys of sentinel chicken flocks and farm flocks have been made annually since 1957 to determine the levels of encephalitis virus activity in the Bothwell area. In this area, antibody rates for western encephalitis in chickens increased from 20 percent in 1957 to 57 percent in 1960.

Entomological investigations during the decade 1948-58 have shown that Culex tarsalis and Culex pipiens, primary vectors of encephalitis, are prevalent mosquitoes in northern Utah and southern Idaho. During the outbreak of encephalitis in 1958, populations of both species reached unusually high levels in northern Utah. Production of these mosquitoes occurs in a wide range of aquatic habitats in both foul and fresh water. In northern Utah, field observations have shown that aquatic habitats associated with irrigation are especially favorable for the production of these mosquitoes. These habitats include both semi-permanent and permanent bodies of water such as flooded depressions on fields, roadside ditches, flooded wasteland, and seepage areas.

Several species of vicious-biting Aedes mosquitoes also occur in the area. Large numbers of these mosquitoes may create public health problems by interfering with the healthful outdoor activities of both children and adults during the summer months. Individuals, particularly children, frequently require medical attention and sometimes hospitalization for treatment of secondary infections and allergic reactions resulting from mosquito bites. The Aedes mosquitoes may be produced in temporary surface pools associated with irrigation and in ponds and reservoirs which have shallow vegetated areas subject to fluctuating water levels. Overflow pools along streams also provide favorable larval habitats for several species of Aedes mosquitoes prevalent in the area.

In addition to their public health importance, large numbers of biting mosquitoes also cause severe economic losses by lowering meat and milk production, by reducing the efficiency of agricultural and industrial workers, by interfering with recreational enterprises, and by lowering the value of real estate.

Vectors of terrestrial origin, including arthropods such as ticks, mites, fleas, and flies, and rodents such as ground squirrels, chipmunks, rats, and mice, may be important at recreational sites along the shores of reservoirs. In addition to the irritation, discomfort, and annoyance caused by arthropod bites, the public health importance of these vectors involves a number of human diseases including Rocky Mountain spotted fever, Colorado tick fever, relapsing fever, tick paralysis, dysentery, typhoid, tularemia, typhus, and plague.

The production of mosquitoes and other aquatic insects of public health importance is widespread in many irrigation areas. Natural breeding places occur in most irrigated areas, but usually the man-made mosquito sources are frequently caused by the same faulty irrigation and drainage practices that cause serious soil and water problems such as excessive water losses, waterlogging, erosion,

salt and alkali accumulations, damage to soil structure, leaching of plant nutrients, and reduced crop yields. Mosquito sources commonly associated with irrigation may be grouped into three principal categories: (1) those related to storage reservoirs; (2) those related to irrigation conveyance systems, and (3) those related to use of irrigation water on the farm and the disposal of excess water.

The conditions associated with storage reservoirs which are conducive to mosquito production include emergent vegetation and/or flottage and debris in shallow water areas and embayments that are protected from wave action; undrained depressions, borrow pits, sloughs, and swamps within the fluctuation zone; rising or constant pool levels which cause the water to remain in the marginal vegetation for more than four or five consecutive days during the mosquito breeding season; and marshy seeps below dams. It is often difficult to control mosquito production on a reservoir that has not been properly prepared prior to impounding. The principal preimpoundage preparation measures for mosquito control include: clearing of the reservoir basin; final removal of vegetation from the fluctuation zone prior to impounding; and drainage for depressions, sloughs, and swamps within the fluctuation zone. Of paramount importance is the fact that the maximum benefits from water level management for mosquito control can be realized only when the reservoir has been properly prepared. Several phases of water level control, particularly flood surcharge, constant level pool, and cyclical fluctuation and/or seasonal recession can sometimes be adapted to irrigation storage reservoirs in order to minimize conditions favorable for mosquito production. A particular phase may be used primarily to destroy mosquito larvae, or it may be directed at vegetation or flottage favorable for mosquito production. A flood surcharge above the upper normal pool level for a few days in the spring prior to the mosquito breeding season followed by a sharp drawdown is effective in stranding objectionable flottage. The invasion of marginal vegetation can be limited by holding the reservoir at a constant level during the early spring growth period. This phase is especially important since it will increase the effectiveness of subsequent fluctuation or recession. Seasonal water level recession used alone or in combination with periodic fluctuation is a very effective control measure since it provides a clean shoreline which is unfavorable for mosquito production.

When unlined irrigation canals and laterals are constructed in pervious material, a large percentage of the water is lost by seepage through the beds and banks. In areas with poor under-drainage, these seepage losses in combination with deep percolation from irrigated lands often result in marshy seeps and

ponded water in roadside ditches, borrow pits, and numerous other undrained depressions. Such habitats, which may occur on both irrigable and nonirrigable lands, produce tremendous numbers of mosquitoes, especially C. tarsalis, the common encephalitis vector. Large numbers of Aedes mosquitoes are also produced in seepage areas that have fluctuating water levels. In addition to creating conditions favorable for prolific mosquito production, seepage also causes excessive loss of irrigation water and serious damage to valuable agricultural lands. Mosquitoes are also produced in various other types of water areas associated with irrigation conveyance systems. Typical examples are ponded areas where canals block natural drainageways, residual water in turnout structures, stilling basins and other hydraulic structures, and pools caused by leakage from turnouts and other water control structures. Although such habitats are generally of minor importance in comparison with those caused by seepage and the numerous other breeding places that occur in irrigated areas, they also contribute to the overall mosquito problem.

In many irrigated areas, the most important mosquito sources are those associated with the use of water on the farm and the disposal of excess water. Studies on several operating irrigation projects have shown that mosquito sources in this category are usually caused by poor irrigation and drainage practices and also result in serious agricultural problems, including reduced crop yields. These practices include inadequate land preparations; use of field layouts and irrigation methods that do not fit land, crops, and water supply; application of water in excess of crop requirements; inadequate drainage systems for disposal of excess water, and poor maintenance of distribution and drainage systems. All of these practices contribute to the development of both "on-field" and "off-field" aquatic habitats which are favorable for prolific mosquito production. Permanent and semipermanent aquatic habitats produce large numbers of C. tarsalis, and intermittently flooded areas produce tremendous numbers of Aedes mosquitoes.

Mosquito sources on irrigated fields have been found to occur most often on those used for pastures, hay meadows, and other close-growing crops. In order for the aquatic stages to mature and produce adult mosquitoes, ponded water must be present for at least four or five days. Observations in several irrigated areas have shown that when water is ponded on fields long enough to produce mosquitoes, the better forage grasses and legumes are frequently killed and replaced by undesirable wetland plants.

Heavy mosquito production also occurs in numerous "off-field" aquatic habitats. Many of the mosquito sources located outside irrigated fields are caused by improper disposal of excess water. Roadside ditches, borrow pits, depressions on wasteland, and numerous other undrained areas are flooded by excess irrigation water when farm and trunk drainage systems are inadequate. Such habitats produce large numbers of C. tarsalis and other mosquitoes of public health importance.

The reduction in flooding of lowland areas located downstream from the proposed reservoirs should result in a reduction in natural aquatic habitats which are favorable for the production of mosquitoes and other aquatic insects of public health importance. Portions of the reservoirs that have steep shores with little or no vegetation and are exposed to strong wave action will be unfavorable for the production of mosquitoes and other aquatic insects of public health importance, and will require no special vector prevention or control measures. Mosquitoes and other aquatic insects of public health importance may be produced in tributary embayments and other marginal areas of the reservoirs where the topography is flat and the water is shallow, protected from wave action, and contains emergent vegetation or flottage. In such areas appropriate measures for prevention and control of aquatic vectors should be provided. The development of recreational and other public use areas at various locations along the shores of the reservoirs may result in the exposure of humans to vectors of terrestrial origin including arthropods such as ticks, fleas, and flies, and rodents such as ground squirrels, chipmunks, mice, and rats. In order to minimize public health hazards at waterside recreational areas, appropriate prevention and control measures for both aquatic and terrestrial vectors should be carried out.

Numerous mosquito-producing areas exist throughout the presently irrigated areas, many of which are directly related to poor irrigation and drainage practices. Some of the most serious mosquito sources are associated with poor soil and water management practices employed by the water users. Provision of a larger supply of water for lands presently irrigated and the development of additional irrigated areas may aggravate existing mosquito sources and create new aquatic habitats favorable for mosquito production unless appropriate prevention and control measures are built into the project and continued as a part of the regular operation and maintenance. Leakage from unlined canals and laterals combined with deep percolation from the higher irrigated lands may cause existing seepage areas to increase in size and others to appear unless adequate prevention and control measures are provided. Other mosquito sources may be aggravated or created unless adequate drains are installed for the removal of excess irrigation water and natural surface runoff. Irrigation farmers should be encouraged to use improved soil and water management practices which will also prevent and minimize mosquito sources.

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APPENDIX "A"

STANDARDS OF PURITY AND REGULATIONS, STREAM CLASSIFICATIONS, STATE OF UTAH

Class "C" waters shall be so protected against pollution as to be suitable at all times for domestic water supplies which are treated before use by coagulation, sedimentation, filtration, and disinfection. Class "C" waters shall be suitable without treatment for irrigation, stock watering, fish and wildlife propagation, recreation (except swimming), as a source for industrial supplies, and for other uses, as may be determined by the Board.

No person shall discharge into Class "C" waters any wastes --

- (1) which result in chemical characteristics of said waters exceeding the limits prescribed by U. S. Public Health Service Drinking Water Standards as of February 6, 1946, or
- (2) which result in chemical characteristics of said waters exceeding the recommendations for irrigation water quality as outlined in Chapter 5 of the U. S. Department of Agriculture "Agriculture Handbook No. 60," issued February 1954, or
- (3) which result in a monthly arithmetical average "most probable number" (MPN) of coliform organisms in said waters exceeding 5000 per 100 milliliters, or in an MPN exceeding this number in more than 20% of the samples collected during any month, or in an MPN exceeding 20,000 per 100 milliliters in more than 5% of such samples, or
- (4) which result in a monthly arithmetical average biochemical oxygen demand (BOD) in said waters exceeding 5 parts per million (ppm), or in a BOD exceeding this amount in more than 20% of the samples collected in any month, or in a BOD exceeding 10 ppm in more than 5% of such samples, or
- (5) which result in any slicks, floating solids, suspended solids, or sludge deposits in said waters which are readily visible, or which result in an appreciable change in color of said waters, or
- (6) which result in a pH of said waters lower than 5.0 or greater than 9.0, or

- (7) which contain any toxic wastes, phenols, or other deleterious substances in such concentrations or at such temperatures as will render said water injurious to fish life and waterfowl, or unsafe or unsuitable as sources of water supply for domestic use, food processing or industrial use, or unsuitable for agricultural purposes, stock watering, or recreation (except swimming).

Class "D" waters shall be protected against pollution as to be suitable at all times for general irrigation, but not for irrigation of lawns, recreational areas, pastures used for dairy cattle, root crops or any low growing crops produced for human consumption. Such waters shall be suitable also as a source for industrial supplies and for other uses as may be determined by the Board.

No person shall discharge into Class "D" waters any wastes --

- (1) which result in chemical characteristics of said waters exceeding the limits prescribed by U. S. Public Health Service Drinking Water Standards as of February 6, 1946, or
- (2) which result in chemical characteristics of said waters exceeding the recommendations for irrigation water quality as outlined in Chapter 5 of U. S. Department of Agriculture "Agriculture Handbook No. 60," issued February 1954, or
- (3) which result in a monthly arithmetical average "most probable number" (MPN) of coliform organisms in said waters exceeding 5000 per 100 milliliters, or in an MPN exceeding this number in more than 20% of samples collected during any month, or in an MPN exceeding 20,000 per 100 milliliters in more than 5% of such samples, or
- (4) which result in a monthly arithmetical average biochemical oxygen demand (BOD) in said waters exceeding 25 parts per million (ppm) or in a BOD exceeding this amount in more than 20% of the samples collected in any month, or in a BOD exceeding 50 ppm in more than 5% of such samples, or
- (5) which result in any slicks, floating solids, suspended solids, or sludge deposits in said waters which are readily visible, or which result in an appreciable change in color of said waters, or
- (6) which result in pH of said waters lower than 5.0 or greater than 9.0, or

- (7) which contain any toxic wastes, phenols, or other deleterious substances in such concentrations or at such temperatures as will render said waters unsuitable for the uses designated in the introductory paragraph of this section.

On September 7, 1960, the Utah Water Pollution Control Board amended the standards of purity and regulations to include the following:

"Note 1: The Board may assign any one of the foregoing classifications to a given water notwithstanding the presence in said water of natural pollutants in excess of limits established by the classification, in which case the subscript '1' shall be added to the usual classification designation (A₁, B₁, C₁, etc.) to denote the modification of water quality. No change in waste discharge restrictions of the basic classification shall be inferred, except that the discharge of any wastes in such a way as to increase the concentration of any of the excessive natural pollutants in the classified water is prohibited."

"Note 2: Wastes discharged to waters of the State under limitations imposed by a given classification shall be further controlled as required to protect water quality designated by all downstream classifications."